Reg. No. | | | | | | | | | | | | | |

B.E. / B.TECH. DEGREE EXAMINATION, MAY 2023

Fourth Semester

BT18401 – Fluid Mechanics and Heat Transfer

Biotechnology

(Regulation 2018/2018A)

TIME: 3 HOURS **MAX. MARKS: 100**

COURSE OUTCOMES	STATEMENT	RBT LEVEL
CO 1	Summarize the concepts of heat transfer, laws, industrial applications, steady state and transient conduction.	2
CO 2	Compare the properties of heat exchangers and its design, NTU concepts, evaporators and its types.	3
CO 3	Learn the properties of various fluid properties and their applications.	3
CO 4	Experiment with different fluid measurement and calculations of different devices.	4
CO 5	Examine the properties and characteristics of fluid transportation devices.	3

PART- A (10 x 2 = 20 Marks)

(Answer all Questions)

		CO	RBT LEVEL
1.	State Stefan-Boltzmann law of radiation.	1	2
2.	What are fins? How will you calculate its effectiveness in heat transfer?	1	2
3.	Comment on LMTD and AMTD in heat exchangers.	2	2
4.	Point out the applications of heat transfer in bioreactor operation.	2	2
5.	Distinguish between Newtonian and Non-Newtonian fluids with examples.	3	2
6.	If the specific gravity of petrol is 0.72, find its weight, specific weight and density.	3	2
7.	Add a note on minimum fluidization velocity.	4	2
8.	Brief about the working principle of a pitot tube.	4	2
9.	What is Net Positive Suction Head?	5	2
10.	List out the advantages of reciprocating pumps.	5	2

PART- B (5 x 14 = 70 Marks)

		Marks	CO	RBT LEVEL
11. (a)	A glass window with an area of 0.557 m^2 is installed in the wooden outside wall of a room. The wall dimensions are 2.44 x 3.05 m. The wood has a 'k'	(14)	1	4

of 0.1505 W/m.K and is 25.4 mm thick. The glass is 3.18 mm thick and has a 'k' of 0.692 W/m.K. The inside room temperature is 299 K and the outside air temperature is 266.5 K. The convection coefficient 'h_i' on the inside wall of the glass and the wood is estimated as 8.5 $W/m^2.K$; the outside h_0 is also estimated as 8.5 for both surfaces. Calculate the heat loss through the wooden wall and through the glass.

(OR)

(b)	Saturated steam at 267°F is flowing inside a steel pipe having an ID of 0.824 in. and OD of 1.050 in. The pipe is insulated with 1.5 in. of insulation on the outside. The convective coefficient for the inside steam surface of the pipe is estimated as h_i = 1000 btu/h.ft^2.°F and the convective coefficient on the outside of the lagging is estimated as h_0 = 2 btu/h. ft^2.°F. The mean thermal conductivity of the metal is 45 W/m.K or 26 btu/h. ft.°F and 0.064 W/m.K or 0.037 btu/h. ft.°F for the insulation. Calculate the heat loss for 1 ft of pipe using resistances if the surrounding air is at 80°F.	**(14)**	**1**	**4**
12. (a)	Give the general classification of evaporators and their applications in process industries. Explain in detail about the principle and operation of any one type of evaporator with a suitable diagram.	**(14)**	**2**	**3**

(OR)

(b)	Water is flowing at the rate of 1.13 kg/s in a 1-2 shell-and-tube heat exchanger and is heated from 45ºC to 85ºC by an oil having heat capacity of 1.95 kJ/Kg.K. The oil enters at 120ºC and leaves at 85ºC. Calculate the area of the exchanger if the overall heat-transfer coefficient is 300 $W/m^2.K$.	**(14)**	**2**	**3**
13. (a)	Dimensional analysis is to be used to correlate data on bubble size with the properties of the liquid when gas bubbles are formed by a gas issuing from a small orifice below the liquid surface. Assume that the significant variables are bubble diameter D, orifice diameter d, liquid density ρ, surface tension σ in N/m, liquid viscosity μ and g. Select d, ρ and g as core variables.	**(14)**	**3**	**4**

(OR)

(b)	A large storage tank contains oil having a density of 917 kg/m^3. The tank is 3.66 m tall and vented (open) to the atmosphere of 1 atm abs at the top. The	**(14)**	**3**	**4**

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tank is filled with oil to a depth of 3.05 m (10 ft) and also contains 0.61 m (2 ft) of water in the bottom of the tank. Calculate the pressure in Pa and psia at 3.05 m from the top of the tank and at the bottom. And calculate the gauge pressure at the bottom of the tank.

14. (a)	Explain in detail about the principle, construction and working of Orifice and Venturi meter with suitable diagrams. Also highlight their advantages and disadvantages.	**(14)**	**4**	**3**
	(OR)			
(b)	Derive Bernoulli's equation for an incompressible fluid flowing through a pipe with varying diameter and height. Assume the density of the incompressible fluid remains constant at both points and the energy of the fluid is conserved as there are no viscous forces in the fluid.	**(14)**	**4**	**3**
15. (a)	Describe the construction and working principle of a centrifugal pump with a neat diagram. Also highlight their advantages and disadvantages.	**(14)**	**5**	**3**
	(OR)			
(b)	Elaborate on the design and purpose of different types of compressor valves used in process industries.	**(14)**	**5**	**3**

PART- C (1 x 10 = 10 Marks)

(Q.No.16 is compulsory)

		Marks	CO	RBT LEVEL
16.	A black body of total area 0.045 m^2 is completely enclosed in a space bounded by 5 cm thick walls. The walls have a surface area 0.5 m^2 and thermal conductivity 1.07 W/m.°C. If the inner surface of the enveloping wall is to be maintained at 215°C and the outer wall surface is at 30°C, calculate the temperature of the black body. Neglect the difference between inner and outer surface areas of enveloping material.	**(10)**	**3**	**5**